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crease, which can be eventually checked, shows that active commercial killing should have been restored some years ago.

*The destruction of tetanus antitoxin by chemical agents:* W. N. BERG and R. A. KELSER, Pathological Division, Bureau of Animal Industry, Washington. The results indicate that tetanus antitoxin a substance of non-protein nature, but the stability of the antitoxin is so dependent upon that of the protein to which it is attached, that whenever the protein molecule is split, the antitoxin splits with it.

*Tests for fluorine and tin in meteorites with notes on maskelynite and the effect of dry heat on meteoric stones:* GEORGE P. MERRILL, Department of Geology, United States National Museum, Washington.

*Notes on isotopic lead:* FRANK WIGGLESWORTH CLARKE, United States Geological Survey, Washington. Investigations on the atomic weight of various forms of lead, and radioactive estimates of the age of minerals, are analysed for the purpose of throwing light upon isotopes and the structure of chemical elements.

THE seventh number of Volume 4 contains the following articles:

*On the representation of a number as the sum of any number of squares, and in particular of five or seven:* G. H. HARDY, Trinity College, Cambridge, England.

*The crystal structure of ice:* ANCEL ST. JOHN, Department of Physics, Lake Forest College. Ice is properly assigned to the hexagonal system, and consists of four interpenetrating triangular lattices, of which the fundamental spacings have been obtained.

*Fringing reefs of the Philippine Islands:* W. M. DAVIS, Department of Geology and Geography, Harvard University. An interpretation of recently published large-scale charts of the United States Coast and Geodetic Survey.

*Dilation of the great arteries distal to partially occluding bands:* WILLIAM S. HALSTEAD, Medical School, Johns Hopkins Uni-

versity. The relative amount of constriction required to give the most pronounced results has been determined, so that the author is able, in almost every instance, to produce the dilation, and a large amount of material thereby accumulated is analyzed.

*On the correction of optical surfaces:* A. A. MICHELSON, Ryerson Physical Laboratory, University of Chicago.

EDWIN BIDWELL WILSON  
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### SPECIAL ARTICLES

#### INVESTIGATIONS ON THE IMBIBITION OF WATER BY GELATINE

MANY investigators in both botany and zoology have recently been at work on the absorption of water by gelatine and other colloidal jellies and from their results have drawn some extremely interesting conclusions regarding physiological behavior. However as the published results accumulate many apparent discrepancies in actual experimental results are appearing. In an attempt to investigate some phases of imbibition by gelatine, I found difficulty in making my conclusions agree with those of previous workers and even in duplicating my own results. In the course of this work certain phenomena of the behavior of gelatine itself came to light and I am offering the following account of some of the preliminary work which I found necessary, in the hope that it may save other workers needless trouble and perhaps help to clear up some of the discrepancies referred to.

Various authors have emphasized the necessity for using material of a constant chemical composition, and for conducting all comparable tests at the same temperature, but the importance of an identical history of water-content and of water-loss seems to have been overlooked.

As was to be expected, the water-content of the gelatine at the beginning of the absorption, strongly influences the rate of water uptake. However, even when different lots of gelatine have the same water-content at the beginning of the absorption, their ability to

absorb water still depends upon their respective water-contents when they were made up, as Table I. shows. Several lots were made up to the concentrations given in the heading of the table, poured out on glass slabs, and allowed to lose water by evaporation at room temperature until tests showed that all had attained the same water-content (one gram gelatine to 0.17 grams water). Then pieces of the same size and form were placed in distilled water and their increase in thickness measured at intervals. The table shows that the lot which had the highest original percentage of water, increased in size most rapidly. That this meant a real difference in the amount of water absorbed was shown by the tests of the water-content at several stages. After 136 hours the pieces which were originally made up to contain 11 per cent. gelatine, had a water content of 98.4 grams per gram of gelatine. At the close of 160 hours the original 20 per cent. gelatine contained 178.0 grams of water per gram of gelatine, and the 33 per cent. gelatine, 100.0 grams of water per gram of gelatine.

The above results indicate that the evaporation of water from the gelatine influences any subsequent absorbing rate. The evaporational history of the gelatine used affects also the distribution of the increase in size among the several dimensions of any given piece, as is shown by the following conclusions which have been drawn from a large number of experiments. The tables to which reference is made contain fair samples of the many readings taken. The tests were made upon gelatine of several concentrations varying from 10 per cent. to 33 per cent. The pieces referred to were rectangular blocks  $2.00 \times 0.35 \times 0.35$  cm.

1. When no appreciable amount of water has evaporated from the gelatine since it has set, blocks swell equally in length, thickness and breadth. This is true whether five minutes or forty-eight hours has elapsed since the setting. See Table II.

2. These blocks, when placed on a glass plate with their largest faces in a horizontal position, and allowed to lose water by evap-

oration at 18° to 30° C., shrink about twice as much in the two short dimensions as in the long one, shrinking being calculated as percentage of original size. See Table II.

3. When the blocks which had received the treatment mentioned in paragraph 2 above, were placed in water and allowed to swell the distribution of amount of increase among the three dimensions was in the same ratio that the shrinking had been. That is, the increase in size was about twice as great for the two short dimensions as for the long one. This distribution of increase continued for at least 60 hours after the gelatine had attained its original water-content. See Table II.

4. When blocks were cut from freshly made gelatine and hung on a thread with the long axes in a vertical position, where they were exposed to the air on all sides, the same distribution of decrease in size among the several dimensions took place as was described under paragraphs 2 and 3 above. The subsequent increase in size when blocks were placed in water also showed the same relation as formerly. That is, the shrinking and subsequent swelling were about twice as great in the two short dimensions as in the long one.

5. When gelatine was poured into a large dish or on to a glass slab and allowed to lose water by evaporation before pieces were cut, the decrease in thickness far exceeded the decrease in the other directions and the subsequent swelling in water followed the same proportions. For example, 15 per cent. gelatine when treated in this manner showed swelling to the following amounts: Height, 181 per cent., breadth 15 per cent., length 6 per cent. For the behavior of 33 per cent. gelatine see Table III. The more water lost by evaporation, the greater the difference in the swelling of the height and the other dimensions.

The above results indicate that the evaporation of water from the surface of gelatine jelly changes in some way the physical structure of the jelly. There has appeared thus far no evidence to determine whether these changes concern small group of molecules or much larger masses of gelatine. It may be merely that evaporation taking place more

rapidly in one direction than another causes an accumulation of a greater amount of gelatine in the planes perpendicular to that direction and hence more water can be absorbed and greater swelling take place. That this physical change was brought about by the evaporation of water and not by any natural change in the gelatine itself, was shown by comparative tests on the absorbing capacity of gelatine which was allowed to stand for twenty-four hours, with the absorbing capacity of gelatine which was exposed to the air for the same length of time. The first showed an equal swelling in all directions and the second the greatest swelling along the vertical axis (*i. e.*, the direction of greatest evaporation). It seemed at first that gravity might be a strong force in determining the direction of greatest deposition and hence of greatest swelling, but the experiments reported upon in paragraph 4 above show that it is the amount of surface exposed to evaporation that determines the direction of greatest shrinkage. Therefore, the vertical axis usually shows the

TABLE I

Increase per cm. of original thickness of pieces of gelatine which were made up as follows: lot 1, 10 per cent. gelatine, *i. e.*, 1 gram of gelatine to 9 grams of water; lot 2, 13 per cent. gelatine; lot 3, 20 per cent. gelatine; lot 4, 33 per cent. gelatine. All lots were allowed to attain the same water-content by exposure to air at 18–30° C. They were then placed simultaneously into distilled water. The time column indicates the total times of immersion. Each number is an average of measurements taken on six pieces.

Time	Lot 1	Lot 2	Lot 3	Lot 4
16 hours . . . . .	7.80	7.60	5.30	4.90
40 hours . . . . .	9.30	9.30	6.50	5.20
64 hours . . . . .	9.60	11.00	6.95	6.10
88 hours . . . . .	11.00	—	7.30	6.80
112 hours . . . . .	12.00	—	9.90	7.90
136 hours . . . . .	13.20	—	10.50	8.60
160 hours . . . . .	1	—	11.60	10.25

greatest shrinkage or swelling because of the custom of pouring gelatine into dishes open only at the top, or onto slabs where the largest evaporating surface is on top. A further in-

TABLE II

Change per cm. in size of rectangular blocks of gelatine (length = 2.00, height = 0.35, breadth = 0.35). (A) Blocks which have been tightly covered since time of setting, placed in distilled water. (B) Same blocks dried with filter paper and allowed to lose water by evaporation. (C) Same blocks again allowed to absorb water. Ratios are given in brackets below numbers.

Time	No. 1			No. 2			No. 3 <sup>2</sup>			Notes
	Length	Height	Breadth	Length	Height	Breadth	Length	Height	Breadth	
24 hrs. . . . .	0.32 (1.0)	0.33 (1.0)	0.33 (1.0)	0.36 (1.0)	0.39 (1.1)	0.30 (0.8)	0.40 (1.0)	0.42 (1.0)	0.40 (1.0)	Increase. See (A) above.
3 hrs. . . . .	0.27 (1.0)	0.56 (2.1)	0.53 (2.0)	0.21 (1.0)	0.42 (2.0)	0.46 (2.2)	0.22 (1.0)	0.34 (1.5)	0.60 (2.7)	Decrease. See (B) above.
15 hrs. . . . .	0.25 (1.0)	0.47 (1.9)	0.53 (2.1)	0.26 (1.0)	0.55 (2.1)	0.52 (2.0)	0.24 (1.0)	0.38 (1.4)	0.58 (2.4)	Increase. See (C) above.
37 hrs. . . . .	0.31 (1.0)	0.61 (2.0)	0.66 (2.1)	0.32 (1.0)	0.55 (1.7)	0.66 (2.0)	0.27 (1.0)	0.43 (1.6)	0.49 (1.8)	Increase. See (C) above.
63 hrs. . . . .	0.35 (1.0)	0.63 (1.8)	0.74 (2.1)	0.36 (1.0)	0.53 (1.5)	0.67 (1.9)	0.31 (1.0)	0.47 (1.5)	0.45 (1.5)	Increase. See (C) above.

<sup>1</sup> Too soft for measurement.

<sup>2</sup> In the entire experiment 27 blocks were used. Nos. 1 and 2 represent the behavior of 26 of them. No. 3 is given for two reasons: (1) to show that although the shrinking was somewhat differently distributed among the three dimensions, still the

relation between shrinking and subsequent swelling remains; (2) to give an idea of the variations which may be encountered when this method of measurement is used. Reference to the last will be made in a later paragraph.

vestigation into this matter might lead to a better insight into the mechanism of the swelling of gelatine. Whatever the mechanism of the change, it remains that always the greatest shrinkage subsequent swelling take place in axis perpendicular to the largest evaporating surface, regardless of the position of that surface.

In all experimentation on the absorbing capacity of gelatine it is, then, necessary to see that the following conditions prevail: (1) all the gelatine has the same original chemical composition; (2) the entire history of water-content from the time of setting to a jelly to the beginning of absorption must be the same for all the material; (3) if water loss by evaporation is to take place before absorption, then pieces or slabs of the same size and form must be used during the process; (4) if the increase is determined by the measurement of length of one dimension, then all measurements must be made on similar axes; (5) all the gelatine must have been exposed to the same temperature conditions.

TABLE III

Increase per cm. of three dimensions of rectangular blocks of gelatine (length = 0.69 cm., height = 0.15 cm., breadth = 0.30 cm.). Solution was made up to contain 33 per cent. of gelatine, poured onto a glass plate, allowed to lose water until nearly hard, cut into blocks and then allowed to absorb water. Ratios are given in brackets below percentages. Numbers refer to averages of two pieces each.

Total Time	3 Hrs.	127 Hrs.	151 Hrs.	175 Hrs.	202 Hrs.
Length . .	0.36 (1.0)	0.60 (1.0)	0.65 (1.0)	0.91 (1.0)	1.13 (1.0)
Height . .	1.03 (2.9)	1.39 (2.3)	1.60 (2.7)	1.96 (2.2)	1.96 (1.7)
Breadth .	0.30 (0.8)	0.42 (0.7)	0.69 (1.1)	0.88 (1.0)	0.88 (0.8)

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DESERT LABORATORY,  
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ALCOHOLIC BEVERAGES IN DIABETES,  
STATES OF DEPRESSION, AND CON-  
VALESCENCE

In diabetes the oxidative processes are defective, as is indicated by the fact that when

sugar is ingested, it is not oxidized, as is normally done, but is excreted. This defective oxidation results in the accumulation of certain incompletely oxidized substances, acid in nature, thus giving rise to a condition of acidosis which is thought by many to be the cause of coma in the later stages of the disease. Neubauer,<sup>1</sup> Benedict and Török,<sup>2</sup> Allen and DuBois have shown that the administration of alcohol and alcoholic beverages, such as wine and whiskey, facilitates the oxidative processes in diabetes, thereby enabling the diabetic to burn sugar better with resulting decrease in acidosis and sugar excretion.

The present investigation was carried out in an attempt to determine how alcohol favors or facilitates oxidation in diabetes. It is known that oxidation in the body is increased by exercise or work, by the ingestion of food, by thyroid feeding, during the excitement stage of anesthesia, and in combat, and that oxidation is decreased by decreasing the amount of work or the amount of food ingested, during deep anesthesia and in phosphorus and chloroform poisoning. We found that when oxidation was increased in the ways enumerated, there occurred a corresponding increase in catalase, an enzyme in the tissues and possessing the property of liberating oxygen from hydrogen peroxide, due to the stimulation of the liver to an increased output of this enzyme into the blood, and that when oxidation was decreased, there occurred a corresponding decrease in catalase in the blood and tissues due to the decreased output of this enzyme from the liver and utilization in the tissues. From these results it was concluded that catalase is the enzyme in the tissues principally responsible for oxidation. Furthermore, we<sup>3</sup> showed that the catalase of the

<sup>1</sup> Neubauer, O., *Münchener med. Wochenschrift*, 1906, LIII., 791.

<sup>2</sup> Benedict and Török, *Zeitschrift für klinische Medizin*, 1906, LX., 329.

<sup>3</sup> Burge, *American Journal of Physiology*, 1916, XLI., 153; 1917; XLIII., 57, 545, 1917; XLIV., 290; SCIENCE, N. S., 1917, XLVI., 440. Burge, Kennedy and Neill, *American Journal of Physiology*, 1917, XLIII., 433. Kennedy and Burge, *Arch. Int. Med.*, 1917, XX., 892.